PRESERVATION OF TIMBER

SOUVENIR EDITION

THE AUTHOR.

Hand Book of Timber Preservation

Souvenir Edition

By Samuel M. Rowe, C. E.
M. Am. Soc. C. E. and M. W. S. E.

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ROBERT DELOS ROWE (Deceased).

M. Am. Soc. C. E.

To whose labors and intelligent studies and investigations
much that is most valuable in this work is due,
this book is affectionately dedicated.

PREFACE.

These pages are intended for the use of our patrons, past, present and future, and are not for publication; and it is our wish and request that those receiving the book keep it in their own possession, making such use of it as may be to the interest of the railroad company represented.

Since 1885, when the matter was first taken up under the tutelage of the late Joseph P. Card, the author has labored to perfect the methods and appliances, studying each principle and all questions connected wiih the operation of timber preserving in the direction of convenience, economy and effectiveness. Most of the matter contained is original, and this is the first attempt made to furnish a complete practical guide for the operator, containing full directions, that has been made in this country. Those so far operating works of this kind have relied upon training their own operator and carefully refraining from letting any but general items of information go out.

In a general way, the book is an epitome of the experience and observations of the author, assisted by Robert D. Rowe, recently deceased, giving results of much labor, study and time.

It is not pretended that the operator can take the matter up from the book and proceed at once to run

the business, as there is too much that calls for a trained and matured judgment; but the book will be of much service as a hand book and guide during the operation of the plant as well as to hints during the construction.

The author is but too sensible of the imperfect arrangement of the work and that much is yet to do to make it complete, but trusts to be able to offer in the near future an edition that will correct, to some extent, the imperfections of this.

In conclusion, we cannot do better than quote from remarks made by Henry Goldmark, M. Am. Soc. C. E.: "The whole question of timber preservation is, after all, one of economy. The point is not whether the ordinary or an improved creosote process is the best thing, but whether something else much cheaper will not, at least for railroad ties, serve a useful purpose." This we think is no longer a question.

NOTE.—Railroad managers wishing extra copies for use in their own works will be supplied on application.

PRESERVATION OF TIMBER.

INTRODUCTORY

Section 1. The primary purpose of this treatise is to furnish and collate such information as to the practical workings as shall enable the operator to fully understand the philosophy and principles involved, and to serve as a hand book of information, both during the construction of the works and during the operation of the same.

In the preservation of timber, the machinery to be used, as well as the movements and methods used in the operation of the process, are somewhat complex; just as in the manufacture of steel, in the process of making or refining sugar or of almost any line of mechanical business, so that to insure proper results the operator must not only have a thorough knowledge of the principles involved, but must have a thorough training in the method of handling the plant.

In the first place the works are expensive, the amount of capital involved in the erection and equipment is a very large amount; then the chemicals are costly, hence any mistake in handling or failure to do good work is an expensive mistake, indeed.

The appliances for the treatment of timber have been brought to such degree of efficiency that, if properly handled, there is little chance of failure or disappointment in the results.

VARIOUS PROCESSES USED.

Sec. 2. While, as generally conceded, the use of dead oil product of coal tar, usually called creosote,

has shown in some cases high results, yet for several reasons reference to it will be but incidental, and attention will be given almost exclusively to that of the Burnett and to the Zinc-Tannin or Wellhouse processes, in which the chloride of zinc is the preservative agent. There are two reasons why the creosote process will be largely restricted in its use. In the first place, the process is very expensive, the oil being more and more costly from year to year, and in the second place, there is the difficulty and uncertainty of getting a suitable article. Its much greater cost will necessarily restrict its use to cases where the amount of timber is small and the lasting quality of the timber paramount.

On the other hand, the zinc-tannin process, costing but a fraction of that of the former, has been found only less effective, showing an economy that is very marked, especially when applied to the treatment of railroad cross-ties and bridge timber. It is therefore the purpose to treat here of this matter with reference to this line of work.

As the Wellhouse process is a modification of the Burnett, the latter will be noticed only incidentally, but the former, being the more complex, will be treated of at length.

ZINC-TANNIN OR WELLHOUSE PROCESS. METHODS AND RULES.

Sec. 3. The Zinc-Tannin or Wellhouse process for treating and preserving railroad cross-ties, bridge or other timbers against early decay, consists in first subjecting the timber to the action of steam in an air-tight, sealed retort for such length of time as is found necessary to open the pores of the timber and loosen and expel the natural saps. This is followed by a vacuum of from 18 to 26 inches, thereby withdrawing all the vapors and freeing the timber from condensations of steam introduced and of the volatilized saps.

Sec. 4. This is followed by the introduction of

zinc-chloride in solution one and a half to three per cent strong, as the character of the timber under treatment shall require, the solution carrying at the same time one-half of one per cent in weight of dissolved glue.

This solution is held under pressure of 100 pounds for a period of two and one-half hours to six hours, depending, as before, on the character and condition of the timber treated.

Sec. 5. The retort is then freed by forcing the chloride solution back into its receptacle and introducing a one-half of one per cent solution of tannin and holding it under pressure, as with the zinc and glue, for two hours or thereabout and then withdrawing it, completing the operation. This process is sometimes varied by introducing the glue in a separate solution, in which case a separate tub will be necessary for the glue solution.

Sec. 6. This process under consideration differs from the Burnett only in the addition of the glue followed by the tannin, the glue and the tannin combining and forming a leathery and insoluble product which helps to render the timber impervious to the absorption and giving off of water, so protecting the chloride, which is supposed to be easily washed out of the timber, thus losing its antiseptic effect.

Sec. 7. The wide range in time is necessary to meet the difference in the character and condition of the timber, and the proper and most economical and effective practice can only be fixed by first determining what absorption can be secured, and thenceforward conforming to this. This can best be done by varying the time or the strength of the solution, or both.

Sec. 8. A very important requirement is that the timber being treated shall have a reasonable amount of seasoning, say sixty to ninety days, varying in length of time as climatic conditions shall vary.

In a warm, dry climate, sixty days may be ample,

while in a moist, cold climate much more time will be necessary to fit the timber for good results.

Sec. 9. The amount of antiseptic introduced, and its thorough dissemination through the piece, is the essential point to be attained.

It is only by careful observation and study by an experienced management that the best results can be secured.

CAUTION.

Sec. 10. The process and methods here outlined have been in practice many years with results that place them beyond the sphere of experiment, hence any departure from them with a view to improve should be guarded against and deprecated by the management. Any experiments in the direction of improvement should be made by those competent to direct and situated to carry out a long series of experiments. Even this should be attempted with caution and hesitation, as it takes long to get definite results.

APPLIANCES.

Sec. 11. The appliances used are much the same as those for the Burnett or creosote processes, the minor appliances for preparing the chemicals only differing. In each and all the steaming is identical, and the storing tanks and piping are interchangeable from one process to the other.

First—The steam plant for furnishing the necessary steam to the retort, for driving the different pumps and machinery, including a dynamo to furnish light, and to steam coils for heating the works.

The electric light is quite essential, as the works should run night and day.

Second—The retort, sometimes called the cylinder, made of steel plate, and of such dimensions as will receive the charge with its tram cars on which the timber is loaded in such shape as to fill the cylin-

der as nearly as possible. The retort most convenient is usually about 106 feet in clear length, capable of receiving thirteen tram cars with their loads of eight-feet ties, and of such diameter as is deemed most suitable and convenient, generally about six feet. It contains tracks on which the tram cars run, the gauge of which is the same as that of the tram-yard tracks, by means of which the charge is run in and out.

The retort is provided with a strong door, self-sealing, or may be hand-bolted as may be desired, fitting tightly to resist pressure and to prevent leakage and waste.

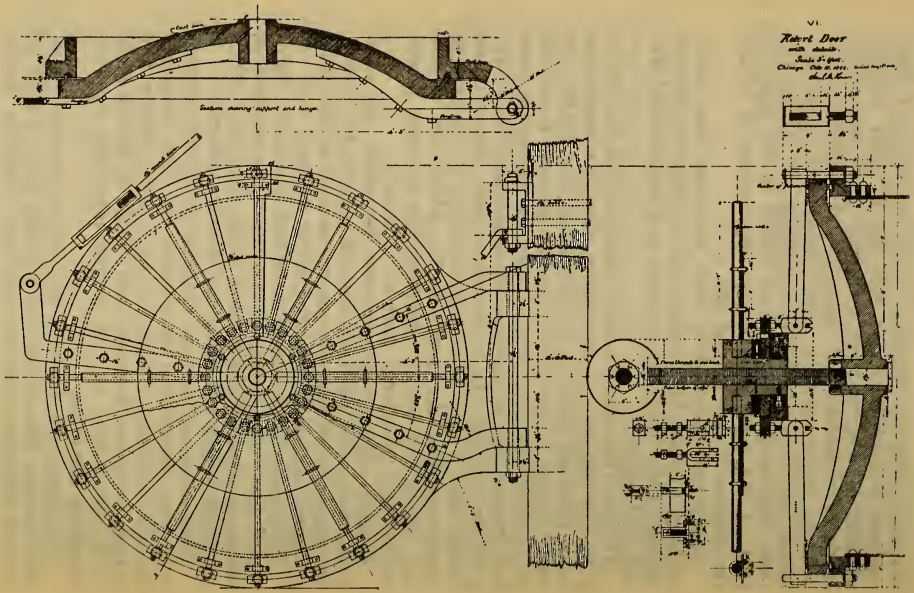
Third—The vacuum pump, used to free the retort from air and vapors remaining after the steam has been released from it, to encourage the outflow of natural saps of the timber and to prepare it for the ready absorption of the solution by freeing it from hot vapors and expanding the small amount of vapors remaining. In connection with the vacuum pump, and a very important adjunct, is the surface condenser and the hot-well, by which the vapors are condensed before reaching the vacuum pump, relieving it of a large part of its labors.

Fourth—The air compressor, by which the solution used is forced back into its receptacle quickly, by pumping air into the retort, as well as for other purposes where compressed air is desired.

Fifth—The force pump, by which pressure is produced upon the charge in the retort, a boiler-feed pump, a pump for handling water for the various purposes about the plant and for fire security.

Sixth—Large tanks or receptacles for the various solutions, consisting of a tank for the prepared chloride solution, a tank for the tannin solution and a tank for water storage, each of which should be of such dimensions as will amply meet the requirements of the plant.

Standard railway tanks will do for a small plant, say for two retorts, but for a larger plant a tank 30 feet in diameter and 20 feet deep, holding some-



Spider Door for Retort.

thing like 100,000 gallons, is about what is most suitable. These may be of wood, iron bound except for creosote, which should be steel throughout.

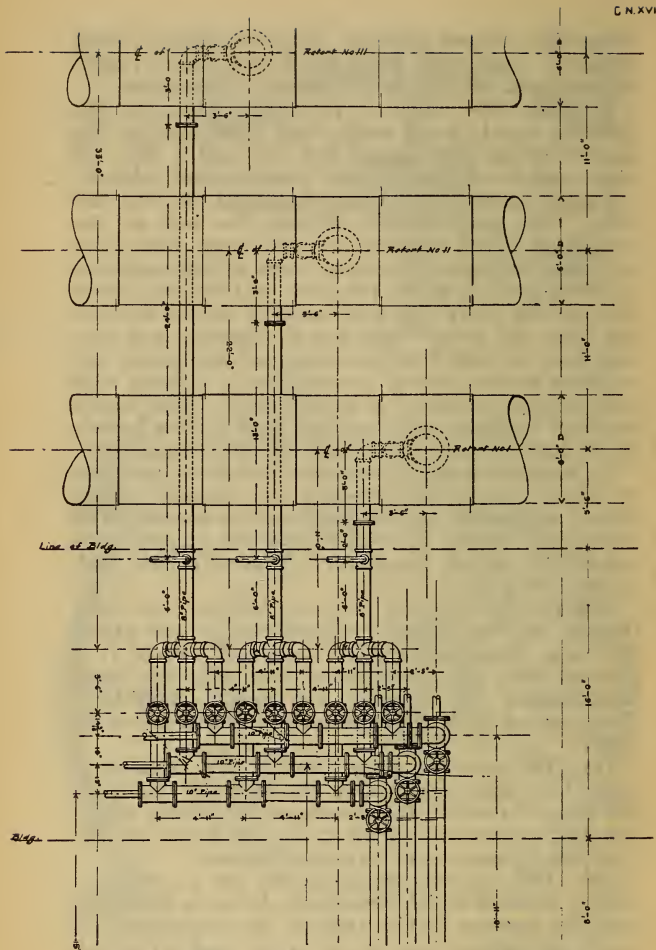
Seventh—The vats for the preparation of the chloride should be of wood, lead lined, the one for dissolving ten feet square and two and a half feet deep, and the storage vat for concentrated solution, say eight by twelve feet and three and one-half feet deep. The concentrated chloride, as well as the acid used in its manufacture, are both destructive to iron or even steel, hence a lining of half-inch lead is interposed on which the acids will not act, hence will last for years. A small mixing tub for dissolving glue, say about eight feet in diameter and four feet deep, in which it is soaked and dissolved, and to some extent diluted preparatory to mixing with the chloride solution, is usually used. The tannin requires a similar tub, in which four or five barrels of the bark extract can be emptied, diluted and used.

To each of these mixing vats or tubs is provided an ejector, by means of which the contents can be forced up into the proper receptacle as needed. The pipes and valves, through which the concentrated solution is passed, must be of chemically pure lead, as the lining is.

Eighth—The system of iron piping to carry through all the different movements is too extensive and complicated to be described, except in a general way, as almost every case calls for some modification on account of special conditions. They can be divided and described in the following order:

(a) The solution pipes consist of a system of large iron pipes connecting the solution tubs with the retort by which the movement is quickly made, the full control of which is in the hands of the operator by means of a system of valves.

(b) The air and vacuum pipes are a system of piping through which connection between the retort and the vacuum pump and the air compressor is made, by which vacuum is drawn and by which



Main Solution Pipes for three movement.

Solution pipes for three movement for Zinc-Tannin plant.
Rowe & Rowe.

air is forced into the retort in forcing back the solution to its receptacle, and also by which the steam or the air is released from the retort.

(c) The circulating system is a system of minor pipes, including a force pump by which a plentiful stream of cold water is forced through the surface condenser during production of vacuum, by means of which the steam and vapors from the retort are condensed and cooled before reaching the vacuum pump.

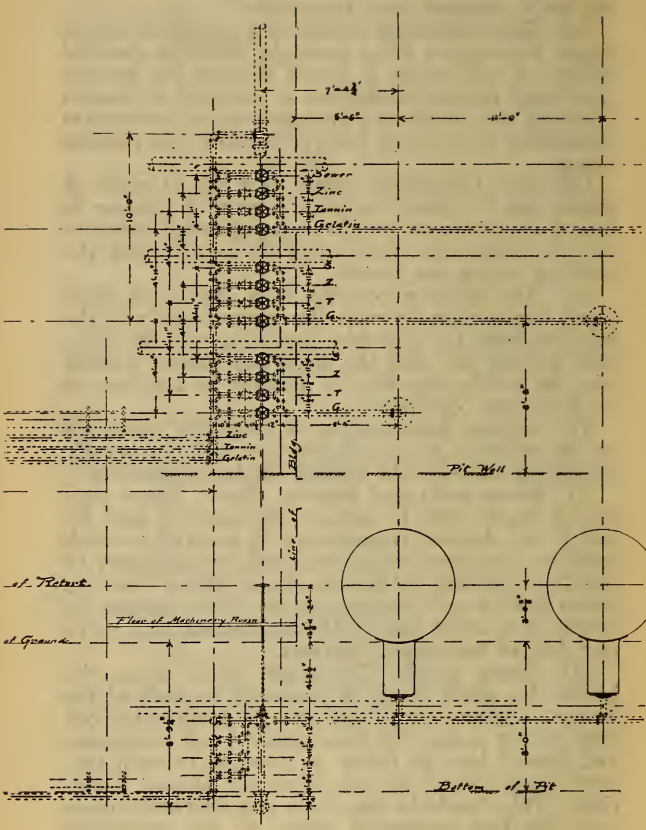
(d) The blow-back system is a set of pipes of minor size by which the last remnant of solution is forced back into its proper receptacle by means of the air compressor continuing its service after the solution valves are closed.

(e) The puddler consists of a system of small pipes connecting between the compressor and the solution tubs, the chloride dissolving vat, the chloride storage vat and the glue and tannin mixing tubs, by which they may be agitated by a stream of air from the compressor.

This is quite important, as it keeps the chemicals in the solution in suspension and aids in rapidly dissolving those in the mixing or dissolving vats.

(f) Steam coils and heating pipes. These consist of steam coils in each of the solution tubs by which the desired temperature is secured to each solution; also such radiators as may be necessary to heat the building, all having steam direct from the steam boilers and discharging all condensations by means of a steam trap to the boiler-feed tank or to any desired hot-water reservoir.

(g) Steam pipes. The steam pipes from the boilers by which steam is furnished to each of the pumps, engines, etc., need not be further noticed here except to say that they should be of ample size and should lead as direct as possible to each machine, and should be well protected against radiation. This should be especially and effectually done with the line conveying steam to the stationary



Blow-back System. Three Retorts.

power by which charges are handled, which are located at considerable distance from the boilers.

(h) Suction and discharge pipes of the various pumps need here only be mentioned.

(i) Service and security against fire.

In large plants, a large force pump connecting with an ample supply of water in case of fire breaking out, the discharge of which, with its pipes, to the various parts of the works, and sufficient number of hydrants and ample supply of hose, is a very important adjunct. It may be made to do general pumping service at the same time being always ready for a fire.

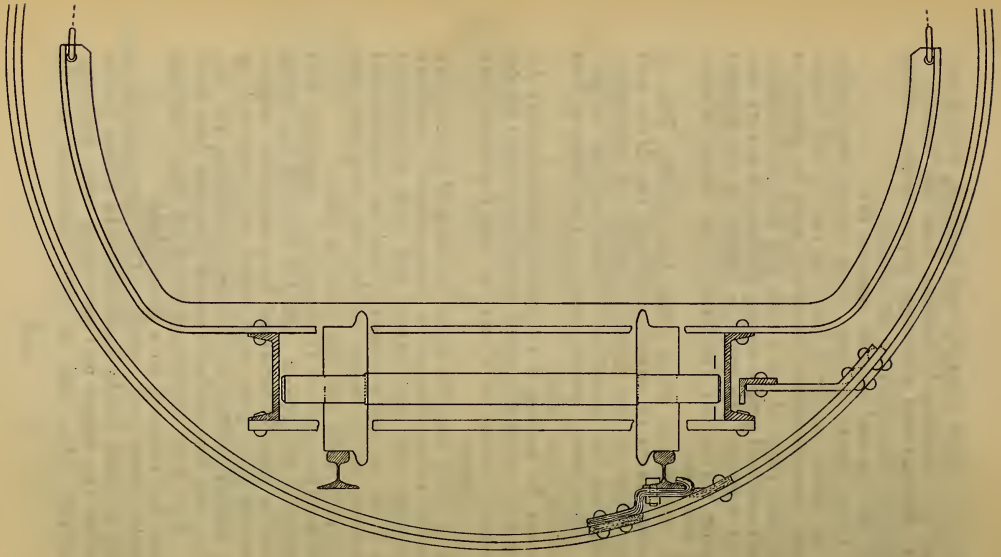
(j) Automatic drain from the retort. This is an arrangement of pipes connecting the drain well of the retort to the sewer by which all condensations during the operation of steaming shall be carried to the sewer, thereby keeping the retort as free as possible from water.

It may be arranged to operate automatically by means of a steam trap, or it may be operated by the operator by means of a valve in case the steam trap fails to operate.

All of these systems must be planned and plainly delineated to work together harmoniously, nowhere interfering with each other, and each constructed so as to do its work properly, and the outlines and dimensions put on paper so that the shop men can make every piece and put it in its place.

Ninth—The power required for charging and discharging the retort, and for moving the tram cars in the yard, is furnished by a stationary engine. By means of a drum and cables supplemented by fixed snatch pulleys in different positions, the operation can be carried several hundred feet each way. Two and sometimes more of these shifting engines are required in a large plant.

Tenth—Tram-yard tracks. This consists of a system of tram tracks conforming in gauge to the tracks in the retort and extending with switches, cross-overs, etc., such as the dimensions of the



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— SECTION OF 78" RETORT - WITH CAR. —

Chicago Mar. 23d 1909. (S.M.R

1 Foot

works shall require, by which timber is brought from a standard railroad yard or from storage piles and conveyed to and from the retort, and again discharged into piles or loaded on cars for reshipment. While the gauge of these tracks must be the same as that in the retort, yet heavier rails may be used, and 48 to 56 old rails can be utilized.

Eleventh—Loading and unloading platform.

As the amount of material to be handled is great, and the timber is very heavy and unwieldy, every care must be taken to reduce this labor to a minimum. The elevated platform, conforming to the height of the floor of a car, has been found a very great help, the charge from the retort being run up an incline on to it and there unloaded into cars for outshipment.

Twelfth—Steam derrick. Where timber and piling are treated in connection with cross-ties, and the quantity justifies, a traveling steam derrick is very useful, especially with long piles and timber.

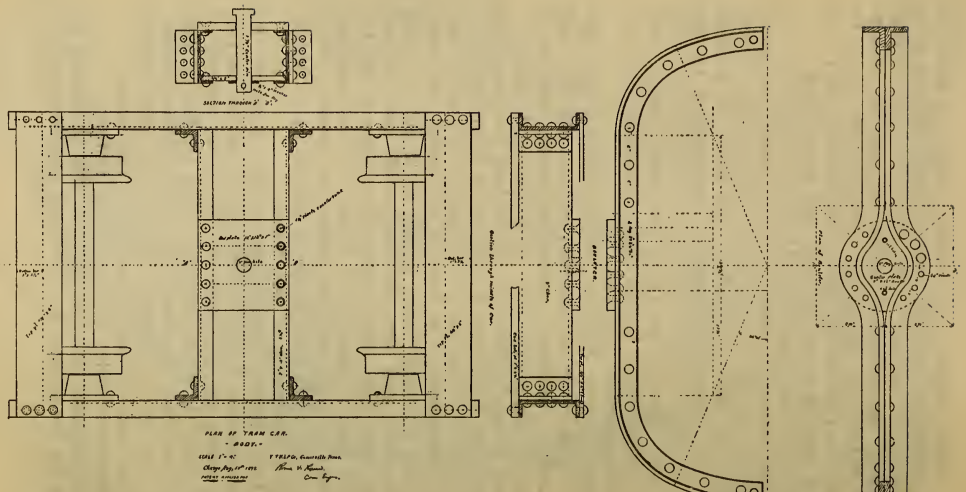
Where gondola cars are to be had for outgoing ties, the tram loads can be placed in them bodily.

Thirteenth—Tram cars or buggies, on which the timber is designed to be treated, or loaded, are compactly and strongly built, weigh from 800 to 1,000 pounds each, and are provided with two curved arms on each side, conforming to section of the retort, and have a capacity of from 30 to 45 standard cross-ties, as they may be hewn or sawed. With length of tie eight feet, 12 to 14 cars make a charge, depending on length of the retort.

For long timber and piling a car of much the same dimensions, but provided with a strong bolster turning freely on the center of the tram, instead of the two pairs of arms, is used. The timber or pile is loaded on two cars and, by means of the bolster, the car can turn curves freely in the yard where curves are unavoidable in works of any extent.

Fourteenth—Scales for weighing timber.

As the amount of absorption of the chemicals in solution by the timber is of the first importance, any



Bolster Car for Timber.

means necessary to determine this accurately should be employed. The indicator measurements is the one of main reliance in determining this, and to check this a four-ton platform scale, set in the tram track at a convenient point for weighing, is perhaps the best means to be devised. On this a tram load or a single piece can be weighed, first before treating and again after, whereby knowing the weight and strength of the solution, the amount of the chemical absorbed, can be determined accurately.

Fifteenth—Buildings.

Where a plant is to be operated continuously day and night, and in all climates and kinds of weather, the buildings must necessarily cover and protect the machinery and appliances effectually. Ordinarily, wooden buildings or wood covered with corrugated iron on sides and tar paper, tar and gravel for roof, are found best adapted to the purpose. These can be made to effectually shelter the works, are cheap, and as the plant and its operation are not always permanent, this form of building is best adapted to easy removal, with little loss, if the necessity comes. The buildings particularly required are:

(a) The building covering the retorts.

(b) The machinery room, containing all pumps, valves and machinery, with the exception of the shifting engines in the yard. The machinery must be compactly arranged so as to be under the eye and hand of the operator.

(c) The boiler room containing the boilers, feed pumps, etc.

(d) The chloride vat room.

(e) The storerooms for storage of chemicals.

(f) Blacksmith shop and repairing room.

(g) Office.

(h) Housing for shifting engines.

Sixteenth—Lighting.

A small electric plant is almost indispensable. It may consist of a small steam engine operated by steam from the boilers and a dynamo good for ten arc lights of 1600 c. p. or its equivalent, furnishing

four or five lights outside and any desired number of incandescent lights inside.

RULES OF OPERATION.
GENERAL.

Sec. 12. In operations where the plant consists of one, two or three retorts, it is usual to start the charges about an hour apart, so that the use of compressor and vacuum pump will not interfere and can be applied to each retort in turn; thus all three retorts can be operated by the one machine. If the plant has more than three retorts, say four or six, then a second compressor and vacuum pump will be required, and the retorts can and should be run in pairs.

Each retort requires its own force or pressure pump and its separate system of piping for solution, steam and air, so arranged as to serve each retort in its turn.

The details of operation, more specifically given, are divided about as follows:

(a) Preparing the charge and manner of loading the timber.

As it is essential that the steam and the solution, each in its turn, shall have free access to all sides of the timber (each piece), a space must be left or reserved for this, especially for sawed stuff, otherwise the operation will be greatly impeded or entirely defeated.

A compactly loaded mass of timber will act much as if it was still unsawed. This has been exemplified in the nine-foot retort, where, even with quarter-inch iron strips between, the steaming requires from three to four times as long a time as that required where the pieces are properly separated, and the same is true as to pressure on solution. A one-inch strip, or an ordinary barrel stave, will do with sawed ties. Hewn ties do not need this.

In loading, the ties should be arranged to conform to the loading gauge, so that there will be no

interference in charging, and there firmly chained, care being taken to have the load even at the ends so as to allow the inspector easy access for counting and stamping.

The stamping die should be a hammer about the weight of a small railroad spike maul, weighing three and a half to four pounds, with handle similar and with the die full faced and deeply cut (three-eighth-inch), vertical and not tapering, securing an impression deep enough to last as long as the timber itself.

The loaded cars are then assembled to make the proper charge, and are then, by means of the shifting engine, cables and pulleys, drawn into the retort, the doors closed and sealed, when all is ready for:

(b) Steaming.

The steam is introduced into the retort, preferably at each end and nearly at the bottom. Meanwhile the blow-off at the top of the retort is kept open to allow the air to escape until the retort is full of steam. When the retort is entirely filled, the blow-off is closed and the steam is accumulated until it has reached a pressure of twenty pounds per square inch and there held throughout the entire remaining time required—four to six hours. This pressure is fixed as the maximum, as the temperature of the steam is then at near 250 degrees Fah., about all that the timber will bear without scorching and injury to its fiber. Frequently during the steaming, the condensations should be drawn off from the retort, by means of the automatic blow-off, to the sewer, accelerating the dryness of the steam and reducing condensation, and securing greater dryness in the timber after the vacuum is drawn. The steam is then blown off, being discharged into the air.

(c) The vacuum.

When the steam is fully blown off the retort should be allowed to cool for a little time, the circulating water should be started through the surface

condenser and allowed to flow, insuring the greatest degree of cold surface to the hot vapors from the retort before the vacuum pump is started, thus preventing these hot vapors from injuring the valves of the pump.

In a one or two retort plant, one of the force pumps can be utilized for pumping the circulating water; but in a large plant, either the service and fire pump will answer, or a special pump will be necessary.

Thus having cooled the condenser, the vacuum is drawn, raising it as fast as is practicable to 20 at 26 inches, and there holding it for half an hour or more, if desired. If the hot-well catching the condensation fills so that the contents are thrown off through the vacuum pump, and it is desired to measure it, resort must be had to an auxiliary reservoir, so arranged as to receive the surplus when necessary. The practicability of measuring these condensations with a view to determine the amount of sap extracted from the timber, is a matter of doubt, and will be noticed further on.

A marked advantage has been secured in treating obdurate timber (dense, wet or green), by interposing a vacuum at an intermediate time during the steaming, blowing off the latter, drawing a vacuum and again introducing the steam while the vacuum is still held. This idea is worth investigating when opportunity offers.

It is practicable to have a suction pipe connecting the drain-well of the retort with the hot-well by which any condensations gathering will be collected in the hot-well during the vacuum operation.

(d) Introducing the chloride solution.

The vacuum having been on for sufficient time, it is still held, and the valve in the solution pipe is opened and the solution allowed to flow in, which it does very rapidly by the help of the vacuum, until the retort is entirely filled, the air pipe being opened to allow the escape of the remaining air in the retort and then closed.

The solution should be heated from 80 to 100 degrees Fah. before introduced, as it is found that the chloride is held best in suspension at about that temperature.

When the retort is filled and the air pipe closed, the force or pressure pump is at once started and the pressure raised to 100 pounds per square inch, which should be done in a very short time, and there held for such time as shall be judged best to meet the nature of the timber.

A measuring vat, in which the estimated quantity of solution that the charge should receive is held, is recommended by some as a good thing, as, by attaching the suction of the pressure pump to the vat and running it until the vat is exhausted, the timber will have absorbed the proper amount of the solution.

Careful reading of the indicator about the time the pressure from the pump begins, and then again at times during which pressure remains, will give a very close measurement of the amount absorbed during that time, but of course there is no means of determining how much was absorbed before pressure was secured. The indicator reading before introducing and again after forcing back, gives the most accurate measurement possible, except, perhaps, the weighing before and after.

(e) Returning the chloride solution to its receptacle is the next move, and is accomplished by means of the air compressor by which air is forced into the retort. When it is quite cleared the valve in the main solution pipe is closed, and the blow-back is used to clear the retort of the last remnant of solution, which is carried to its proper tub by an overhead pipe.

(f) Introduction of the tannin solution.

As soon as the chloride solution has been cleared from the retort, the tannin solution is introduced, put under pressure and so held for the desired period, and forced back to its receptacle in every respect as with the chloride, except that the time held

under the pressure of 100 pounds need not be so long, as the action of the tannin is quite superficial.

This completes the operation. The doors being opened, the charge is removed from the retort. The next charge being prepared is run in, the doors are closed, and the whole program is repeated. A charge takes from 10 to 12 hours.

RULES FOR MIXING CHEMICALS.

ZINC-TANNIN OR WELLHOUSE PROCESS. CHEMICALS USED.

Chloride of Zinc. ($Zncl_2$.)

Sec. 13. The principal antiseptic agent used in this process is the chloride of zinc. The chloride can be made on the ground by the combination of hydrochloric acid (muriatic) with common metallic zinc, or the commercial product in the form of a salt furnished in large drums or rolls protected by a covering of thin sheet iron. There is but little difference in the cost, the difference being in favor of the commercial article.

(a) By empiric experiment the hydrochloric acid and the zinc combine about as follows: 800 pounds Hcl_2, 20 degrees B to 100 pounds Zn., will produce 813 pounds of 46 per cent zinc chloride, or 375 pounds of pure chloride. With acid at 1½c per pound and the zinc at 5 6-10c, the cost per pound pure chloride will be about 5.6c per pound.

(b) One reason in favor of manufacturing or preparing the chloride at the works is that its quality and purity are more easily controlled against adulterating impurities. Its preparation may be done by having two dissolving vats, so as to prepare one while the other is being used.

(c) The commercial chloride being most readily obtained and more convenient to use, is being generally used, hence, in the rules here given, the commercial chloride will be understood.

(d) The impurities in the salt should not exceed three per cent in weight, and are, with one exception, quite harmless, except as an impurity. The presence of a small amount of iron, however, say one-half of one per cent, should condemn it, as the iron neutralizes the chloride and at the same time is said to injure the wood fiber.

(e) The commercial salt will often have a small amount of free, uncombined acid, which is destructive to wood fiber if present in any great amount, hence the dissolving as well as the storage vat should contain a liberal allowance of the zinc blocks to take it up, and the time allowed for its action should be as extended as possible.

(f) A graphic table of weight and specific gravity of chloride of zinc is here given, which gives the data on which the table for quantities, in Table "B," is computed. While it is not claimed to be exact, yet it gives a sufficiently close approximation and serves the purpose. It is the summing up of numerous trials.

GELATINE (Glue).

Sec. 14. Commercial glue of good quality contains the gelatine which, under the Wellhouse process, forms a part of the plugging up substance by its combination with the tannin. Glues vary considerably in the amount of gelatine contained, but 60 per cent is supposed to be a fair estimate for a good commercial article.

(a) The per cent in weight of water at 60 degrees Fah. that any glue will absorb, is said to be about the best test of quality. A first-class glue, it is said, will absorb 13 parts of water to 1 of glue, but it is found that some of the best cabinet glues will not take over 5 or 6 in the 24-hours' test.

(b) It has been, and now is, the practice to use a solution in combination with the chloride consisting of one-half of one per cent of the total in glue. The tannin solution, containing the same amount of

tannin extract which will combine in about equal parts, forming with the glue the leathery substance in the wood pores.

(c) The specific gravity of a fair glue should be, when perfectly dry, about 1.42, and should readily take six times its weight of water when immersed in it at 60 degrees Fah. for 24 hours.

To determine the specific gravity of any sample of glue, take a graduated tube, say a 200 c. cm. measure. First put in 100 c. cm. water, then weigh out one ounce of the dry glue and drop it into the tube, noting, immediately, the point to which the water is raised by the addition of the glue. The difference in the height of the water in the tube before and after adding the glue, will be the volume of the one ounce of glue in cubic centimeters, from which its weight and specific gravity can at once be computed.

(d) Then to determine the amount of water it will absorb, add to the above another 100 c. cm. of water, place it in a place where the temperature is constant at 60 degrees Fah. for 24 hours, when the proportion of water unabsorbed will appear clearly to the eye. Note this in c. cm. and divide by the whole 200 c. cm. of water, thus determining the proportion absorbed.

(e) In a one-half of one per cent solution of glue, the specific gravity will be inappreciably greater than pure water, so that the only means of determining its strength is to carefully weigh in the dry glue whenever the solution is renewed, the quantity of glue being always the one-half of one per cent by weight of water charged with the glue, and computed in the same ways as for the chloride solution.

(f) It is usual, on account of impurities in the glue, to discount these by putting in an excess, say where 100 pounds of tannin is called for, use 110 pounds of glue. While it is understood that the glue and the tannin combine in about equal quantities, yet it is safe to have a slight excess of the for-

mer, for the reason that if glue should be entirely or even partially absent there would be no action by the tannin, and it would go back into the solution tub as strong as before used. In any case, if sufficient glue is not present, full action of the tannin cannot be expected.

TANNIN EXTRACT.

Sec. 15. The tannin extract of hemlock bark is mostly used in this process, containing from 15 to 30 per cent of tannic acid, presumably about a safe mean of 22 per cent.

(a) As the amount of active properties in the combination, both as to the glue and the tannin, long practice has taught that they should be used in about equal quantities. As the glue is first absorbed, and the tannin following neutralizes so much of the glue as it may reach, the overplus of the tannin being carried back with the returned solution, there is no waste by having the tannin solution markedly stronger than the prescribed one-half of one per cent. The strength of the tub solution of tannin should be tested from time to time by comparison of its action on a reagent, as will be explained later on.

(b) As regards the penetration of the tannin into the timber, although the tannin solution is complete, that is, the acid is held in complete suspension and will go wherever the water will go, yet its action is and must be largely superficial from the fact that it has no such aid or favorable conditions as does the chloride solution. That there is a portion of the glue not reached by it is a matter of speculation, and it is probable that owing to the viscosity of the glue its action is also largely superficial as well. Be this true, it is what it should be.

(c) The hemlock bark extract carrying the tannic acid is of a reddish brown color, hard when

cold, but when under temperature of 100 degrees Fah. or over is the consistency of thin molasses and flows freely.

Its specific gravity is about 1.22, but when a half of one per cent solution, there is no appreciable excess over pure water.

(d) The commercial extract is put into barrels holding about five hundred pounds and over, four or five barrels usually making a batch.

To thoroughly dissolve, a quantity of water is added and a moderate amount of steam is turned in by means of a small steam pipe in the tub, by which the extract is thoroughly agitated and moderately heated, after which additional water can be added, so that some fixed depth from the mixing tub will equal the quantity of tannin needed for each tub foot in the tannin solution tub.

(e) When tannin and glue are combined the mixture, after time is given for the combination of the two, and all unassimilated portions are washed out, and the residuum dried, gives a dark-brown, semi-transparent substance that is quite hard and brittle. It is insolvent in water and incombustible, simply charring to a cinder much as would be with charred leather. Under the microscope, it has the appearance of an opaque resin, and a similar substance by appearance is found in the sap cells of the treated timber, not in untreated timber.

PREPARATION OF CHEMICALS FOR USE.

Sec. 16. The chloride of zinc.

(a) Dissolving: The fused chloride (commercial) should be dissolved into stock solution, a concentrated solution from 35 to 50 per cent strong, some little time before used, say 24 hours if practicable, so that it shall be thoroughly dissolved, and that any free acid it may contain will have time to be taken up by the spelter (zinc) kept in the dissolving vat for that purpose.

The drums or rolls of fused chloride should then

be divested of the iron covering, weighed, and if the works are provided with a trolley carrier, be placed bodily in the dissolving vat, or in absence of the trolley, they should be broken into smaller fragments and dropped from planks placed over the vat, which should have been previously partially filled with water. In placing the pieces in the vat, care must be taken that the lead lining of the vat be not injured.

(b) The following will guide as to the amount of the salt to be weighed in, and as to the amount of water for dissolving. First fill vat about half full, and then add the chloride and fill with water to the height indicated:

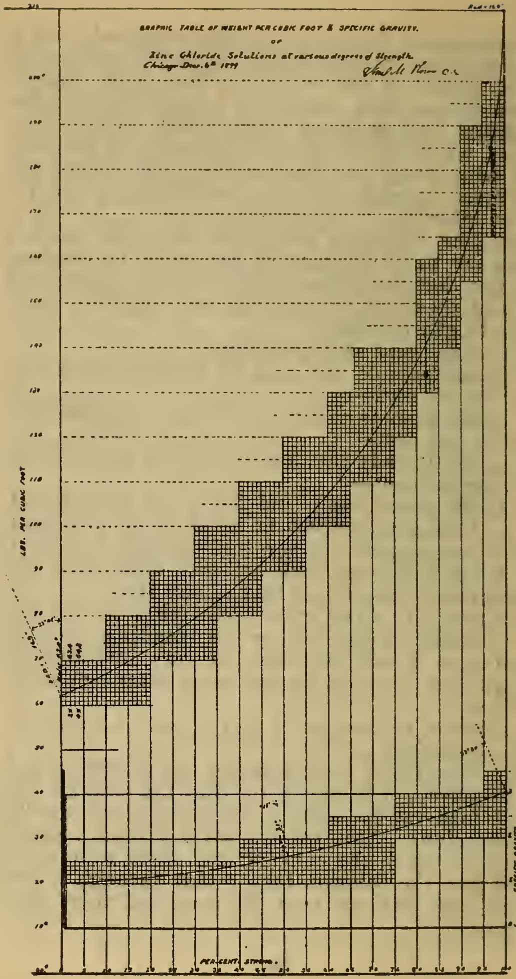
For 35 per cent stock solution—
6,296 pounds salt, and fill to 2.2 vertical feet.
For 40 per cent—
7,865 pounds salt, and fill to 2.3 vertical feet.
For 45 per cent—
9,285 pounds salt, and fill to 2.3 vertical feet.
For 50 per cent—
10,860 pounds salt, and fill to 2.3 vertical feet.

(c) This computation is based upon a mixing vat ten feet square and two and one-half feet deep, and, being lead lined with half-inch sheet lead, has approximately an area of 99.4 square feet.

The above is a fair guide, remembering that the exact amount of the salt or the resulting strength of solution is not essential, as any intermediate strength can be used by the same means of computation.

A solution of from 40 to 50 per cent is about the most convenient.

(d) When this stock solution is well neutralized and dissolved, it is drawn off into the storage vat, a lead-lined vat the same as the mixing vat, except in dimensions. This vat is provided with a steam ejector by which the concentrated stock solution is forced into the solution tub or tank through a discharge pipe passing over the top and there discharging.



Weight and Specific Gravity of Chloride ($Zncl_2$) Solution.

-TABLE "B."- Cubic feet concentrated solution Chloride of Zinc, ($ZnCl_2$), required for each tub foot, for 30' dia. tank, the mean area of which is 664 square feet.

Area of tub (a.) = 664 sq. ft.
* Wt. of sol. (b.) 63.4 lbs. cu. ft.
Per cent sol. req'd. (c).
Total * pure $ZnCl_2$ req. (d).
Str. conc. sol. (30 to 60% (s).
Wt. per cu. ft. " " " (t)
Cu. ft pr. tub ft. req'd (x).
Then:
a.b.c. = d.
and $\frac{d}{s.t.} = x$.
For any other value of a, say a'; then $\frac{a'}{a} \times x = x'$

Values of (c).	Values of (st).	Strength of concentrated Solution in storage vat. (s).	30.	35.	40.	45.	50.	55.	60.	%
1¼% strength	in cu/ft	4.418	5.618	3.017	2.550	2.186	1.886	1.635	1¼
1½% "	" " "	26.506	21.711	18.104	15.303	13.114	11.132	9.808	1½
1¾% "	" " "	30.929	25.329	21.121	17.853	15.300	13.196	11.443	1¾
2 % "	" " "	35.347	28.948	24.140	20.404	17.652	15.082	13.079	2
2¼% "	" " "	39.345	32.223	26.871	22.712	19.464	16.788	14.557	2¼
2½ % "	" " "	44.183	36.185	30.173	25.540	21.857	18.852	16.347	2½
2¾% "	" " "	48.602	39.800	33.318	28.055	24.042	20.738	17.983	2¾
3 % "	" " "	52.558	43.422	36.180	30.606	26.229	22.623	19.616	3.
3¼% "	" " "	57.480	47.041	39.225	33.156	28.415	24.508	21.252	3¼
3½% "	" " "	61.852	50.660	42.243	35.706	30.601	26.393	22.886	3½
3¾% "	" " "	66.233	54.278	45.260	38.499	32.786	28.279	24.521	3¾
4 % "	" " "	70.651	57.896	48.248	40.807	34.952	30.164	26.156	4.
conc. sol. Lbs. Cu.ft.		79.40	83.10	87.20	91.70	96.30	101.50	107.30	

Note. * includes ½ % Gelatine.

This is computed for a wooden slave tub, area at .4 of height. By substituting mean area of any other size of tub, (a), the table can be computed in the same manner.

The table gives for each 5 per cent between 30% and 60%; interpolate for intermediates.

To estimate for vertical feet needed, divide the cubic feet (x), by the area of the store vat.

Chicago May 15th 1900 (Original.)-

Attest- W. W. Bell

Paul M. Rowe C.E

PREPARATION OF DILUTED TUB SOLUTION.

Sec. 17. (a) Assuming the size of the storage vat to be 8 by 12 feet, area being 96 feet, and the solution tub being 30 feet in diameter, wood and iron bound, with a mean area of 664 square feet, then we have for putting up the stock chloride from storage vat to the diluted solution tub, Table "B," giving the number of cubic feet of stock solution for each tub foot required, hence by multiplying this by the number of tub feet to be charged, and dividing the result by the area of the storage vat (96 sq. ft.), gives the vertical feet to put up.

Dilution of Chloride Solution.

(b) To make up the first tub of solution, say two per cent strong, fill solution tub with water to say 17 feet, the tub being 20 feet deep, each tub foot being equal to 664 cubic feet (mean area of tub) by 17 vertical feet, equal 11,288 cu. ft. multiplied by 62.3 lbs. (weight of cu. ft. of water) equals 703,242 lbs. water.

Then as 98 per cent of water is to the two per cent of chloride, so is 703,242 lbs. of water to 14,352 lbs. pure chloride required.

Then for cubic feet in volume of the two per cent chloride we have: Water, 702,242 lbs., which divide by 62.3 lbs. equals 11,288 cu. ft., and chloride, 14,352 lbs., which divide by 200.0 lbs., equals 71.76, making total of 11,359.76 cubic feet or about 17.2 vertical or tub feet.

DETERMINING STRENGTH OF CHLORIDE SOLUTION.

(c) No more satisfactory means have been found for testing the strength of the chloride solution than the Beaumé Hydrometer, using the coarse hydrometer, one to sixty degrees for the concentrated and the fine hydrometer, one to six degrees, divided to 1-10th degree, for the highly diluted solutions. In

the heavier solutions, say 30 to 60 degree, the influence of temperature is small, so that no account need be made for it, but with that highly diluted it is necessary to define the effect of temperature very carefully to get true measurement of strength.

To meet this, the table (A), Nos. I., II. and III., has been prepared by means of empiric tests subjected to a law of curve developed by trial, by which a close approximation has been made. Comparison of calculated quantities used in one month's run, with the actual quantity of stock used, has served to confirm the exactness of the tables.

Table No. V. gives the same graphically, the curves described being true spirals both as to the variation under increased heat and for the points at which the per cent of strength agrees with the degrees Beaumé.

The use of the hydrometer is impracticable with the glue and the tannin solution, either being about the same specific gravity as water.

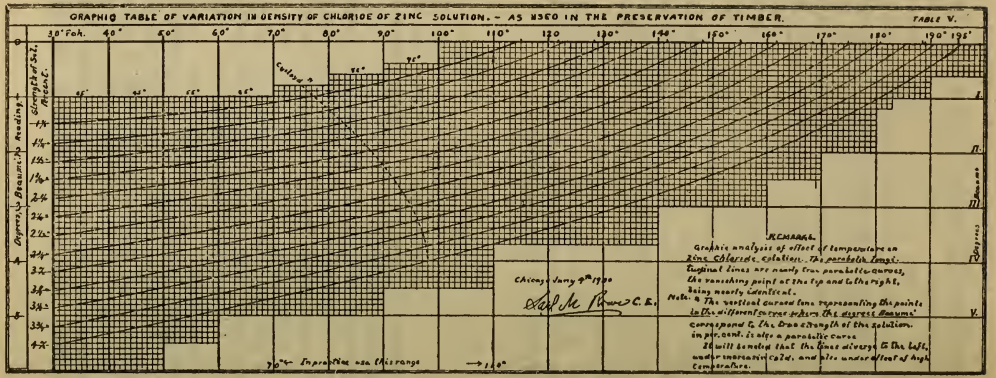
WATER FOR DILUTION.

Sec. 18. It is here proper to notice the character of the water to be used in this connection in making up the chloride solution.

In carrying through the process, a considerable quantity of water, variously estimated at 15 to 25 thousand gallons per day per retort, including the supply for steam and circulating purposes as well, is used. Pure water is very desirable and its quantity is important, for, should it be bounteous, much may be saved in water saving appliances. There are some locations where it is desirable to locate works that the quantity is meager and the quality is poor.

Sec. 19. Alkaline waters usually found in the western plains and mountains is, while undesirable, yet not unusable as while the effect is to some extent deleterious, yet not to the extent that would forbid its use. One of the effects is its liability to

TABLE "V."



Influence of Temperature on Chloride Solution ($Zncl_2$). ROWE & ROWE.

TABLE "A," No. I.

FAH. THER. READING.

Str. Sol.	70°	1	2	3	4	5	6	7	8	9	80°	1	2	3	4	5	6	7	8	9	90°
1 %	1.11	1.10	1.09	1.08	1.06	1.04	1.02	1.01	0.99	0.97	0.96	0.93	0.91	0.89	0.88	0.86	0.83	0.81	0.79	0.77	0.75
1¼ "	1.41	1.40	1.39	1.37	1.36	1.35	1.34	1.32	1.29	1.27	1.25	1.22	1.21	1.19	1.17	1.15	1.13	1.11	1.09	1.07	1.05
1½ "	1.78	1.70	1.69	1.67	1.65	1.63	1.61	1.60	1.58	1.56	1.54	1.52	1.50	1.48	1.46	1.45	1.43	1.41	1.39	1.37	1.35
1¾ "	2.01	2.00	1.99	1.97	1.94	1.93	1.91	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.76	1.74	1.72	1.71	1.69	1.67	1.65
2 %	2.31	2.30	2.29	2.27	2.24	2.23	2.21	2.20	2.18	2.16	2.14	2.12	2.10	2.09	2.07	2.05	2.02	2.01	1.99	1.97	1.95
2¼ "	2.61	2.60	2.58	2.56	2.54	2.52	2.50	2.49	2.47	2.45	2.43	2.41	2.39	2.38	2.36	2.34	2.32	2.30	2.28	2.26	2.24
2½ "	2.91	2.90	2.88	2.86	2.84	2.82	2.80	2.78	2.76	2.74	2.72	2.71	2.69	2.67	2.65	2.63	2.61	2.59	2.57	2.55	2.52
2¾ "	3.21	3.20	3.18	3.15	3.13	3.11	3.09	3.07	3.06	3.04	3.02	3.00	2.98	2.96	2.94	2.92	2.90	2.88	2.86	2.83	2.81
3 %	3.50	3.49	3.47	3.45	3.43	3.41	3.39	3.37	3.35	3.33	3.31	3.29	3.27	3.25	3.23	3.21	3.19	3.17	3.15	3.12	3.10
3¼ "	3.81	3.79	3.76	3.74	3.72	3.70	3.68	3.66	3.64	3.62	3.60	3.58	3.55	3.53	3.51	3.49	3.47	3.45	3.43	3.41	3.38
3½ "	4.10	4.08	4.05	4.03	4.01	3.99	3.97	3.95	3.93	3.90	3.88	3.86	3.84	3.81	3.79	3.77	3.75	3.73	3.70	3.68	3.66
3¾ "	4.40	4.37	4.35	4.33	4.31	4.28	4.26	4.23	4.21	4.19	4.17	4.15	4.12	4.10	4.07	4.05	4.03	4.01	3.98	3.96	3.93
4 %	4.69	4.66	4.64	4.62	4.60	4.59	4.55	4.52	4.50	4.48	4.45	4.43	4.40	4.38	4.36	4.33	4.31	4.29	4.26	4.24	4.21

F.

HYDROMETRIC READING.

TABLE, I. Temp For each Deg. from 70° to 90° and one to 4% strength

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At Chicago Jany 4th 1900.

Witness C. W. Bell

Frank M Rowe for Rowe & Rowe.

TABLE "A," No. II.

Fahrenheit Ther. Reading.

Str. Sol Per. cr.	90°	1	2	3	4	5	6	7	8	9	100°	1	2	3	4	5	6	7	8	9	110°
1 %	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.57	0.54	0.51	0.49	0.46	0.43	0.40	0.37	0.34	0.31	0.28	0.25	0.21	0.18
1¼ "	1.05	1.02	1.00	0.97	0.95	0.92	0.90	0.87	0.84	0.82	0.80	0.77	0.74	0.71	0.68	0.65	0.62	0.59	0.56	0.53	0.50
1½ "	1.35	1.32	1.30	1.27	1.25	1.23	1.20	1.18	1.15	1.12	1.10	1.08	1.05	1.02	0.99	0.96	0.94	0.91	0.87	0.85	0.82
1¾ "	1.65	1.62	1.60	1.58	1.56	1.53	1.51	1.48	1.45	1.43	1.40	1.38	1.36	1.34	1.31	1.28	1.25	1.22	1.19	1.17	1.14
2 %	1.95	1.92	1.90	1.88	1.86	1.84	1.81	1.79	1.76	1.74	1.72	1.70	1.67	1.65	1.62	1.60	1.57	1.54	1.52	1.49	1.46
2¼ "	2.24	2.21	2.19	2.17	2.15	2.13	2.10	2.08	2.05	2.03	2.01	1.99	1.96	1.94	1.91	1.89	1.86	1.83	1.80	1.78	1.76
2½	2.52	2.50	2.48	2.46	2.44	2.42	2.39	2.37	2.34	2.32	2.30	2.28	2.26	2.23	2.20	2.18	2.15	2.12	2.10	2.08	2.05
2¾	2.81	2.80	2.78	2.76	2.72	2.71	2.69	2.67	2.64	2.62	2.60	2.57	2.55	2.52	2.50	2.48	2.46	2.42	2.38	2.37	2.35
3 %	3.10	3.09	3.07	3.04	3.01	3.00	2.98	2.96	2.93	2.91	2.89	2.86	2.84	2.81	2.79	2.77	2.74	2.71	2.69	2.67	2.65
3¼ "	3.38	3.36	3.34	3.31	3.29	3.27	3.25	3.23	3.20	3.18	3.15	3.13	3.10	3.07	3.05	3.03	3.00	2.97	2.95	2.93	2.91
3½ "	3.66	3.64	3.61	3.58	3.56	3.54	3.52	3.49	3.46	3.44	3.41	3.39	3.37	3.34	3.32	3.29	3.27	3.24	3.21	3.19	3.17
3¾ "	3.93	3.91	3.89	3.86	3.83	3.81	3.79	3.76	3.73	3.71	3.69	3.66	3.64	3.60	3.58	3.56	3.53	3.50	3.48	3.45	3.43
4 %	4.21	4.19	4.16	4.13	4.11	4.09	4.07	4.03	4.00	3.98	3.96	3.93	3.90	3.87	3.86	3.82	3.80	3.77	3.74	3.71	3.69

HYDROMETRIC READING. F.

TABLE, II. - from 90° F to 110. for each Deg.

DIRECTION. Take average sample of solution, take temperature and hydrometric reading, then find the latter under the former. and the column of streng at the left of the table will give the true strength.

combine with the zinc chloride, by which a fraction of the zinc is thrown down, reducing its effectiveness to the extent of such combination.

Another effect of the alkaline water is to affect the specific gravity for which allowance must be made, the amount to be determined by a comparison with distilled water at 60 deg. Fah. and subtracting the difference from the hydrometric reading in testing tub solution.

CHARACTER OF THE WORK AND APPLIANCES.

Sec. 20. The business of timber treating is not new, neither has it been successfully employed in all cases. It has had to pass through the various stages of development like the manufacture of steel, Portland cement and other lines of manufacture, with its modicum of failures and successes. Now, when success is to some extent attained, it is believed that the exercise of knowledge and intelligence is the only means by which recurrent failure will be avoided. This fact cannot be too deeply impressed; also that a thorough knowledge of the practical part of the business, the movements of the process and the nature of the agent used, and a thorough training in the practical handling of the works are absolutely necessary to good results. In the operator, to all this must be added a determined purpose to enforce all rules and requirements, otherwise *failure will be almost sure and very expensive.*

Sec. 21. To give the operator a fair show to carry the work properly, his convenience and the efficiency of his force, as well as the economical operation of the work, must be considered and carefully provided for.

Every part of the works should be easy of access and compactly arranged so as to be under the eye and hand of the operator.

Every part should be substantially built so that repairs will be infrequent.

Ample store houses and storage for all material and stock to be used, as well as a good stock on hand, should be provided.

Each machine, pump, engine, boiler, should be selected to perform the kind and quantity of work that is expected from it, as the failure of any one to perform its functions promptly and properly entails a loss of time for the plant and its whole force. Where so much capital is involved, it is worth while to attend to these considerations at the start.

INSTALLATION.

Sec. 22. When the retort and all the machinery are in place and the works generally in condition to commence operation, the following preparatory steps are necessary to prevent confusion and to secure the data that is necessary for future computations and operation.

All tanks, reservoirs, tubs and vats should be filled with water so as to cause the wood to swell to tightness; the steam pipes, with steam and all other pipes, including the retort, with water, so that all leakage can be discovered and cured and that everything be permanently and reliably tight, 150 lbs. cold water pressure to be put on as final test.

The pumps and machinery should be connected and steam put on and everything tested as to its running promptly and in good order.

The retort door should be carefully adjusted so that the gland will correspond exactly with the packing groove in the retort flange and the door swing freely and truly on its hinges; that the locking levers radiate truly from the center and that the "Y" bolts be well adjusted, so that, in closing the door, all the levers will come to bearing at the same time.

VOLUME OF RETORT.

Sec. 23. In computing the amount of absorption, the amount of timber, etc., in volume, it is necessary to know exactly how much the retort holds.

Close the retort, note the indicator reading on the solution tub, then open the main valve and entirely fill the retort with the water, again reading the indicator, and the vertical feet used by the area of the tub will be the volume of the retort. It would be well to include such number of tram cars as are used in a charge of ties, as this will be used in case of ties at all times. This, if carefully done, is more exact than any computation that could be made.

PREPARING THE CHEMICALS.

Sec. 24. Before proceeding to start the works, each of the chemicals must be prepared in such quantities as will keep on hand a stock sufficient to prevent delay in the work. Each solution tub should be filled to near its full capacity with a solution of proper strength, ready for instant use. For this part of the work a carefully instructed assistant should be employed and held responsible for the proper handling and mixing, and also that sufficient stock is held ready for use.

CHLORIDE OF ZINC.

Sec. 25. The preparation of the stock solution and its dilution in the solution tub is fully treated in sections 16 and 17, so that it is only necessary here to notice the method by which the stock of solution is kept up, both in quantity and strength, by more or less frequent renewals. If three retorts are supplied from a 30-foot tub there will be required something like ten tub feet daily, hence this many tub feet should be supplied each day. This operation consists of pumping so many feet of water into the tub and immediately adding the required quantity of the chloride as indicated in table "B," multiplying this by the number of tub feet put up.

For example, suppose that 8½ tub feet is wanted and the water has been put up, the strength to be 2½ per cent and the stock solution is 40 per cent strong. We see by table "B" that it requires 30.173 cubic feet of stock solution to bring each tub foot

up to 2½ per cent, then 8½x30.173 equal 256.47 cubic feet of stock solution. Divide this by area of storage vat (96 sq. ft.) will give 2.67 vertical feet of the 40 per cent chloride to be put up.

Sec. 26. If more than three retorts are operated, an additional storage vat or a larger one will be necessary, as the above indicates very nearly the capacity of one of the size indicated, and another solution tub will be necessary.

Sec. 27. As before indicated, the solution should be tested by means of the fine Beaumé hydrometer to check the strength, and should it, after being well agitated, be found too strong or too weak, then addition of water in the former or chloride in the latter case is required, the amount of each to be computed as before. The deficit in either case will be proportional as the per cent. Table "B" contains quantities for an error of one-quarter of one per cent, which saves trouble sometimes, and is near enough for most cases.

Sec. 28. The matter of monthly stock will be now noticed as the same computation comes in here. At the starting of the works, or at the beginning of each month, there is a certain amount of stock in the warehouse and perhaps more arriving. To keep a proper account it is necessary to know how much stock has been used in the month, or perhaps in a separate lot of timber, hence the stock account should show just how much is on hand at any moment. This will consist of stock in warehouse, stock in dissolving vats, in storage vat and also in the solution tub, and, knowing the strength of each, the whole can be summed up as if it was still in the original package.

The simple rule for solution anywhere near two per cent will be to call each cubic foot equal to 63.4 lbs. Multiplying this by the total number of cubic feet in the tub and again by the hydrometric strength, will give the number of pounds pure chloride in the solution tub. For mixing and storage vats use table "B."

GELATINE.

Sec. 29. Resuming the consideration of glue from Sec. 14, we will take up its preparation with reference to its immediate use at the works. Glue comes to the works in barrels of 250 lbs. or thereabout, and is dissolved in a small tank or dissolving tub into which some water has been put. The packages first being weighed, then broken, and after turning the glue into the tub the empty barrel is weighed and the net amount of glue noted.

Four or five barrels can be used at one time, filling the tub with water, so that the glue be well covered and left to soak for as long a time as the exigencies of the work will allow; preferably 24 hours. A little steam is then applied so as to render the glue homogeneous, adding further amount of water to bring up the volume so that some fixed measure will indicate how much to throw up for each tub foot of the solution.

If a tub foot contains 664 cubic feet of chloride solution, the weight of which is 63.4 lbs., then there will be a total weight of 42,098 lbs., of which one-half of one per cent would be 210.5 lbs. of glue required for each tub foot. But remembering that in Sec. 14 ten per cent is to be added, brings the amount per tub foot to 230 lbs.

Dividing the amount of glue put into the dissolving tub by 230 lbs., will give the number of tub feet that it will supply with the required per cent.

The strength of the glue, whether mixed with the chloride or used separately, is supposed to remain constant, only needing new supply in proportion to the water added in keeping up the stock of solution.

TANNIN.

Sec. 30. The tannin being applied separately and being the last application is prepared in its separate mixing tub or vat and used from there by means of the same ejector as the glue, diluting it in the tannin solution tub in like manner to the glue.

The tannin solution is absorbed to a very much less degree than the chloride (usually only about one-tenth in volume), owing to the timber having already been well impregnated and to the less favorable condition for absorption. The tannin solution actually loses much more of its tannic acid than is contained in the amount of absorption of the charge, it being remembered that some twenty times the amount absorbed has been in contact with the charge with its quota of glue, and therefore is depleted to the extent of the tannin needed to neutralize the glue, therefore the following: Rule for keeping up the strength of the tannic solution:

"To the amount in volume absorbed add the amount of chloride solution absorbed; to the sum of these add tannin equal to one-half of one per cent in weight of tannin extract."

COMPUTATIONS.

DURING OPERATIONS.

Sec. 31. During the operations of the works it is necessary to know how much timber there is in the charge, how much of each solution has gone into it, etc., so as to be able to know that the work is being properly done and that accurate accounts may be kept of the amount of chemicals used. To do this, the volume of the retort should be accurately taken as before noticed (Sec. 23), and the various solution tubs should be provided with accurate gauges, by means of which the operator can note the amount in the tub before starting, at various periods between and at the close of the operation.

These gauges should consist of a graduated board divided into feet and tenths, a good float on the solution in the tub and an indicator weight or pointer working freely by means of a cord up and down the graduated face of the indicator board. This indicator should be placed where it will be in plain sight of the operator and should be lighted at night so as to be easily read.

VOLUME OF TIMBER.

Sec. 32. To compute the volume of the timber in the charge: Take the lowest reading of the chloride indicator from the reading after the solution is fully forced back. This difference is the number of tub feet that was in the retort after absorption is completed, hence, when reduced to cubic feet, will be the number of cubic feet outside the charge, and taking this from the known volume of the retort, the remainder will be the volume of the charge in cubic feet of timber.

ABSORPTION OF CHLORIDE, TANNIN OR GLUE.

Sec. 33. Take the indicator reading after completing forcing back from the reading at commencing, the remainder will be the tub feet of solution absorbed. Reduce this to cubic feet, multiply it by 63.4 lbs. (close approximate weight per cubic foot), which gives the number of pounds solution absorbed by the charge. Then again to determine the number of pounds pure chloride, multiply this by the per cent of strength of the solution (hydrometric, say .02 or .025, as the case may be), the product is the number of pounds pure chloride absorbed by the charge.

Then, again, divide this by the total number of cubic feet in the charge as before found, and the result will be the pounds or fraction of a pound of pure chloride per cubic foot of timber.

The same rule applies to absorption of tannin and also glue where it is applied separately from the chloride, only different in the last multiplier, which is .005 or one-half of one per cent.

ABSORPTION BY VOLUME.

Sec. 34. A very useful and instructive test of timber as to its adaptability to receive treatment is determined by its ability to absorb the solution. This

is found by dividing the number of cubic feet of solution absorbed by the number of cubic feet of timber in the charge.

RECORD OF ROUTINE WORK.

Sec. 35. To have a complete record of the operation a blank form should be provided for the operator to record every move, the directing column being printed on the right hand with any convenient number of columns in blank arranged to the left, say six for the proper entries in ink, each blank column to receive the record of one run.

The items to be entered are as follows: Run Number; Retort Number; Commenced steaming; Twenty pounds indicated (time); Blow off (time); Commence vacuum (time); Twenty-five inches indicated (time); Indicator chloride tank (feet and tenths); Chloride introduced (time); 100 lbs. pressure indicated (time); Lowest point indicator (feet and tenths); Started forcing back (time); Completed forcing back (time); Indicator chloride tank (feet and tenths); Indicator glue tank (feet and tenths); Introduce glue (time); Force back glue (time); Indicator glue tank (feet and tenths); Indicator tannin tank (feet and tenths); Introduce tannin (time); Force back tannin (time); Indicator tannin (feet and tenths).

Number of ties; Cubic feet of timber in run (computed); Absorption of chloride in vol. per cent (computed); Do. do. Glue (per cent vol.); Absorption of tannin (per cent); Strength of chloride solution (per cent hydrometric); Absorption pure chloride to cubic foot of timber in lbs. Time consumed in run (hours); time consumed in shift; kind of timber treated.

On left of last column should be date, temperature of solution when tested, hydrometric reading and signature of operator.

With such a report filled out for each and every run, departure from the prescribed routine cannot be concealed, but will be apparent.

While the requirements above say feet and tenths, it is possible with care to read the indicator to hundredths of a foot, and this should be done.

MEASURING SAPS EXTRACTED.

Sec. 36. Recurring to the practicability of measuring or determining the actual amount of saps extracted from the timber with any degree of accuracy is doubted. It is found that very dry timber, after being steamed, is invariably heavier if withdrawn at end of the vacuum than when introduced, showing that the timber has absorbed a greater amount of moisture than replaces the saps extracted. On the other hand, very green or waterlogged timber will be markedly lighter, the only conclusion we can draw is that more moisture has been withdrawn than went in in the form of condensed steam, but how much sap came out or how much condensed steam passed in and remains in the timber is impossible to tell. The fact of the matter is that during the process of steaming large amounts of the saps are blown out with the condensed steam in keeping the retort clear of condensations, the quantity being of such amount as to load the outflowing water highly with the juices of the timber. This is entirely outside of that collected by the hot well, and of much greater volume.

KIND OF TIMBER AND CONDITION.

Sec. 37. The soft and open grained timbers, such as the southern lowland pine and the mountain pines of the west, have been submitted to treatment with a high degree of success. The life of these pines are, when laid without treatment, from three to four and one-half years when cut from young growing timber in the form of pole ties. Later, hemlock, tamarack and even cottonwood have been used with good result, the life when treated by the Wellhouse process being prolonged very

much. While sufficient record as to the relative life in each case has not been kept, yet it is presumed that it would be found to be at least double, some estimating it at three times.

In the case of heart timber that is sound and well matured the life can be safely placed at 50 per cent higher, as heart timber is more lasting on account of its maturity and firmness of fiber and greater freedom from fermenting juices.

While it is true that sap and open grained timber will absorb more of the antiseptic solution than well-matured heart timber, and is, by some, considered most suitable for treatment, yet it is not clear that the very best timber cannot be treated with equal profit.

The fact probably is, that any timber, not excluding the best white or buroak, will be benefited to such extent as to be profitable and advantageous by the prolongation of its usefulness.

That a compact timber will not absorb as large amount of the preservative is owing to the large amount of solid wood fiber and the smaller per cent of voids in the timber, which only serve for the lodgment of the preservative, hence this should be no reason for barring it out, but, on the contrary, should be in its favor.

The available voids in timber varies from 20 per cent in volume for compact heart timber to over 60 per cent for Texas short leaf pine. The compact timber is not confined to the oak, hickory, etc., but will be found among the pines. In almost all cases the best timber is found in the lower part or butt cut of the tree.

All in all, it is true that the better the timber the better the tie, whether treated or otherwise, in spite of its inability to absorb so much of the antiseptic.

SEASONING.

Sec. 38. To secure the best possible results, any timber should have such an amount of seasoning as

will free it largely of the green saps existing in the live tree when cut, or to such extent as may be practicable by exposure to a dry atmosphere for perhaps from 60 to 90 days; more time in a damp, rainy climate than in a dry, sunshiny exposure.

Practically speaking, the determination of condition of timber suitable must be largely a matter of judgment with the further aid of actual results when put through the process.

If perforce timber is treated while in a waterlogged or green, freshly cut condition, then special means must be resorted to, prolongation of steaming, interposition of extra vacuum, prolongation of pressure on solution, or all of these, but as a rule this should not be done if possible to avoid it, as the results will be uncertain.

Kiln drying is recommended by some, but this adds too much to the expense and cannot be as good in any case as Nature's action with time.

Section 39. Live and growing timber with its natural saps and its sap cells in their normal condition will resist the introduction of any fluid, much on the principle that two bodies cannot occupy the same space at the same time. To be able to introduce any solution, the natural saps of the timber must be in some way freed and expelled from the timber either by being evaporated by drying or must be forced out by heating, loosening and expanding into vapor, as is done under the steaming process. The saps in freshly cut timber will immediately begin to evaporate when, under favorable conditions, the timber is exposed to the air, the action commencing on the exposed surface and gradually advancing toward the center of the piece, but if, on the contrary, it is exposed to much dampness and high climatic temperature, the evaporation progresses very slowly and the fermentation of the juices of the timber will act quickly, forming at once the basis of active decay. The time required to dry the timber by exposure to the atmosphere alone will go far toward its destruction, the fermentation of the

saps forming the fungi of decay, attacking the delicate cells and more delicate and less compact portions of the timber and then the firmer portions, until, in a few months, the timber becomes spongy throughout. Timber that has reached this stage will take the solution freely, but if decay has gone so far as to allow excessive absorption, it will be of little value even if treated.

Sec. 40. Under the action of steam in the retort, the juices are heated to such temperature as will expel them rapidly, arresting any incipient decay and destroying the delicate mechanism of the sap cells, clearing the way for the ingress of the solution. Microscopic examination proves this to be true.

It is, therefore, important that the time the steam is held must be adjusted to the condition of the timber, the most important consideration being that its action shall reach the center of the piece.

The rule here adopted is for 20 lbs. pressure, which is equal to 250 degrees Fah., which is the highest degree of heat allowable to which the timber can be subjected without injury. The steam used should be saturated steam, as with superheated steam the temperature is uncertain, while no special advantage is gained.

THE ECONOMIES.

Sec. 41. The following estimate is based upon the conditions existing on the A., T. & S. F. Railroad line in New Mexico in 1885.

The prolongation of life of the Mountain Pine there used, from a mean of four and one-half years to about twelve years, is quite well authenticated. On this is based the following estimate:

For a period of twelve years.

Untreated tie placed 2 2-3d times

Cost of tie, 35c. x 2 2-3d times. . .$0.93

Cost of placing in track, 2 2-3d ts. .40—$1.33

Treated tie, one, 35c.....$0.35

Cost of treating, 15c..... .15

Cost of placing, 15c..... .15—$0.65

Making a saving in twelve years of 68 cents per tie or five and two-thirds cents per tie per annum.

To more fully appreciate what this means, multiply this by 2640 ties in each mile you have $149.50, or approximately $150 per mile per annum. As the works built in 1885 consisted of two retorts, with annual capacity of 400,000 ties, sufficient to renew 300 ties per mile on 1333 miles, the annual saving on this basis would be something like $200,000.

The Las Vegas Works cost about $30,000, a small part of the annual saving (about 15 per cent).

GENERAL OBSERVATIONS.

Sec. 42. In a general way, the true value of the results must be deduced from the mass of and not from individual cases or of a few specimen pieces.

The variations in density and other conditions are as various as there are varieties of timber or parts in the tree. Then again, even with the most careful inspection timber more or less unsound will come with the rest, to disturb the investigator should he resort entirely to chemical analysis on which to found an opinion as to the thoroughness of the treatment or the value of the results.

Speaking from a practical point of view, the following line of reasoning will apply: The agents used are commercial commodities used in gross amounts as salt is used to preserve meat, a small variation cutting a figure only where large quantities are used, where system will conserve economy, but where no slight variation will affect the efficiency of the treatment. In this the chemist can guard against the purchase of adulterated stock.

Again, the rules and methods for the zinc-tannin and kindred processes are so well defined that the operator, with the exercise of good judgment, can get almost any desired result, and will know just what he is doing as to amount of absorption. He will know that when he puts in a tie weighing 100 lbs. and it comes out weighing 175 lbs. that it has

absorbed 75 lbs., no more, no less, and knowing the strength of the solution, he can safely say that it has just so much pure chemical agent, whatever it may be in it. To determine how much has been absorbed by any or every particular piece in the charge is manifestly impracticable, hence only the gross result is manifest at the time.

It must be remembered that each of the different processes have been carried on for years, and their effectiveness and value are no longer in the field of theory, the proofs of effectiveness having been secured after the lapse of sufficient time to amount to a demonstration. The chemist may find a tie that has been in service 15 or more years that has but a trace of the chemical, and he may find one of the same timber that has failed at less than five years, both having been treated in the same charge, yet for reasons before given this proves nothing as to the real value of the process or of its failure.

The operator that is armed with a thorough knowledge of chemistry has something that will be of great aid to him, but he will find it of much more importance to study the mechanical and physical features of his work, for instance, whether his steam reaches the center of a tie, what the best temperature for his solution, how various timbers are best rendered penetrable, and a hundred other matters vital to the success of the process.

CAUTIONARY.

Sec. 43. In conclusion, and at the risk of repetition, the operator is reminded that it is of the utmost importance that every part of the work is carried out according to the rules laid down, that the condition of the timber be carefully studied and the best method be adopted to meet this, that every precaution be taken to detect any failure that may occur and to take the proper means to rectify this even to a repetition of the treatment, and to labor to instruct those under him in the highest possible degree to the same end.

By no other means can good results be surely obtained, and any mistakes escaping his vigilance, while not immediately apparent, will tell seriously some time in the future.

Extraneous influences will often be brought to bear to have received and treated timbers not in proper condition to be treated, but such should be received under protest if received at all, and a record should be made of these facts. In this way only will the process be protected against unfair charges of failure.

The operator probably will have little control as to timber delivered to him for treatment, but it is his duty to see that each different class or kind is treated separately as far as is possible, and to study the method of handling the process best adapted to each, bringing every check in his reach to bear, not forgetting the weighing and other means of developing the best methods.

BURNETTIZING.

For the Burnettizing process the appliances are the same as for the Zinc-Tannin except that the tubs for the glue and for the tannin can be omitted and that part of the pipings by which they connect to the retort are also omitted. The precaution is usually taken to put in connections for the piping so that in case of change to the other process, that much labor and expense is saved by so doing.

FOR CREOSOTING.

(a) The additions necessary to provide for creosoting are the necessary storage tub, which should be of metal, as well as a dumping tank in which the oil is dumped from the tank car in which it is usually shipped to the works. The capacity of the storage tub depends upon the desired capacity of the works or the portion of the works devoted to creosoting and the amount of timber that is to be treated.

(b) The same pipes are used as with the Burnett except, of course, the main pipe to the header, but these pipes through which the oil is passed must be provided with inside steam pipes by which the oil shall be kept fluid by means of live steam passing through them.

(c) In addition to this the retort must be furnished with a system of heating pipes (steam) of such heating surface as will quickly heat the oil in the retort to the desired temperature. This is done by manifold coils of iron pipes. As the oil must at all times be entirely fluid, the storage and the dumping tubs must also be provided with ample heating coils.

The absorption is secured in the same way as with the Wellhouse or the Burnett process, first by opening the pores of the wood by steaming, followed by the oil under pressure aided by a much higher temperature on the oil.

UNITS IN COMPUTATIONS.

Sec. 44. Line measure, feet, tenths and hundredths, to three decimals.

Cubic measure, cubic feet and fractions to three decimals.

Tub or vat feet equal area of tub or vat x 1 foot (vert.).

Weights, lbs. Avoirdupois to one to three decimals.

Gallons U. S. equal 231 cubic ins., not used as being less convenient than cubic feet.

Weight of water at 60 deg. Fah. equal 62.4 lbs. per cubic foot, or .5771 per oz. Av. (Sea water said to be 64.1.)

Pressure, steam and cold water is counted as per square inch in lbs. Av.

Temperature, Fahrenheit Thermometer (always).

Weight of concentrated sol. $zncl_2$. See table (B) Empiric.

Per cents should be carried to three decimals.

Means by weight except where otherwise specified.

IMPLEMENTS FOR TESTING SOLUTION.

Sec 45. One avoirdupois scale, 4 lbs. down to grains.

One graduated glass test tube, 200 c. cm. will do, 1½ inch. dia. x 12 inch.

One 1000 c. cm. graduated glass to set on scale, with counterbal.

Two plain test tubes, 1½x12 inch.

Two dozen test tubes, ⅝x6 inch, with cork stoppers.

Two glass funnels, 3-inch dia.

One package filters, 6-inch.

Two open glass jars, 4-inch dia. and 6-inch high.

Two Beaumé hydrometers, 0 to 60 deg.

Two Beaumé hydrometers, 0 to 6 degrees, test to exactly 0 in pure water at 60 deg. Fah. (duplicates to meet accident).

One floating thermometer, Fahr. zero to 250 deg.

One argand lamp with stand.

Six four oz. glass beakers.

Three porcelain saucers, say 4-inch dia.

Two galvanized iron pails, 4-inch dia. and 12 inches deep, with wire bail to handle samples of solution.

A half dozen or more glass bottles holding a pint or more and having ground glass stoppers will be useful to hold various reagents used for testing the solutions, some of which are noticed below.

REAGENTS. Methyl Orange, a 1-1000 solution for testing for free acid in the chloride solution.

Ammonia for testing for iron.

Barium chloride for sulphates.

Alum and glue for tannin solution, etc.

TO TEST STRENGTH OF TUB SOLUTION OF TANNIN.

(1.) Prepare reagent as follows:

Pure water, one liter (1000 grammes).

Best glue, three grammes (50 grains approximately).

Alum (sulphate), one gramme (16 grains).

Heat to 100° Fahr. and let stand 24 hours to dissolve, then bottle.

(2.) Make up a small quantity of one-half of one per cent tannin solution as follows: Presupposing that a sample quantity of known strength in tannic acid is kept on hand, then take 12 ounces pure water, add to this 26¼ grains tannin extract (30 grains is close enough), warm and mix well, then filter well through two sheets of filter paper and bottle for further use.

(3.) Then take a small sample of the tub solution, filter well as with the testing solution, then take from each ten cubic centimeters and put each into a test tube by itself adding the same amount of the reagent (No. 1) to each, shake well and cork.

The glue will combine with the tannin in each, the combination settling to the bottom so that the relative amount will be apparent to the eye in two or three hours. If the tannin is all taken up, the superincumbent water will be nascent and clear of color; if not, and the amount of glue is insufficient, the water will be tinged red, and if on the other hand there is more glue than tannin, the water will be turbid and of a whitish tinge. If, however, the tannin is anything near the standard the above will do.

For the following, we are indebted to Octave Chanute, C. E.:

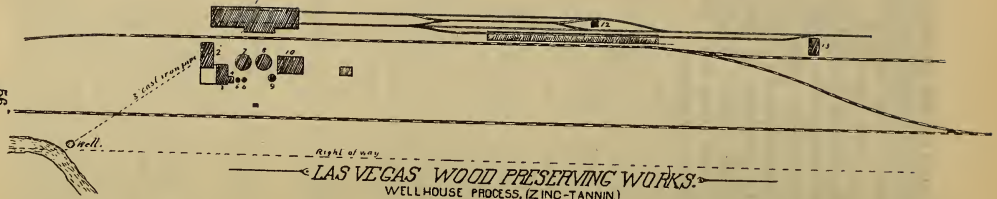
FOR TESTING PURITY OF ZINC CHLORIDE ($Zncl_2$).

For Sulphates. Taking two or three per cent solution, add a little barium chloride. If the result is a milky white precipitate it shows presence of sulphates. The precipitate is barium sulphate.

For Free Acid. To a two or three per cent solution of $Zncl_2$, add a few drops of methyl orange solution (1-1000 solution), and if the methyl orange changes color it shows presence of free acid.

To remove this, one of the most objectionable features and most easily removed, place sufficient zinc spelter (metallic zinc) in the neutralizing vat to combine with and take up the free acid.

For the presence of iron, one of the most injurious of impurities, add ammonia, and shake well. If there is a reddish brown flocculent precipitate, it indicates the presence of iron and the precipitate is ferric hydrated iron. The presence of over one-half of one per cent, the chloride should be condemned. For timber preserving even less than this is sometimes considered sufficient to condemn.


12
13
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1
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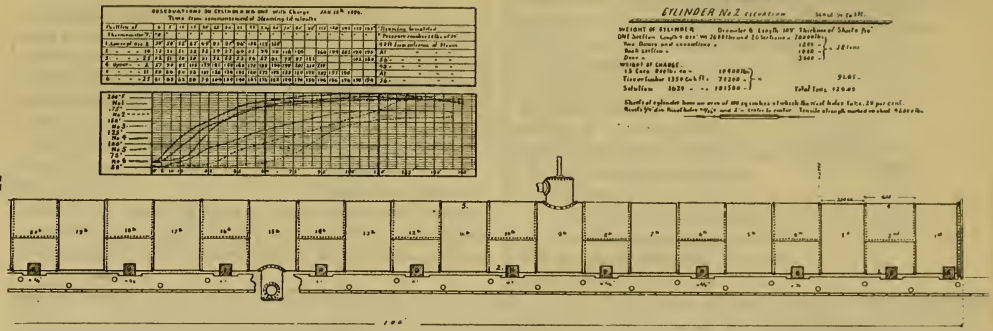
5 cast iron pipe
Well.
Right of way.
LAS VEGAS WOOD PRESERVING WORKS.
WELLHOUSE PROCESS, (ZINC-TANNIN.)
J. P. CARD, President.



Las Vegas Retort showing cause of breakage by introduction of steam at top dome.

PLATE 18. TABLE I.

CONDENSED STATEMENT OF OPERATION OF WOOD PRESERVING WORKS. LAS VEGAS, N.M.

NINE MONTHS ENDING MARCH 31st 1886. (5½ Rows Beat Eng)

MONTH	MURIATIC ACID USED					ZINC USED					GLUE USED					TANNIN USED					COST OF LABOR			COST OF FUEL			TOTAL COST.			AMT. TREATED.	
	Carboys	lbs	Value	Cwt	Price	Blocks	lbs.	Value	Cwt	Price	Bbls	lbs	Value	Cwt	Price	Bbls	lbs	Value	Cwt	Price	Amount	Cwt	Price	Amt.	Cwt	Price	Total.	Cwt	Price	Acr lies	Cubic Feet
July 85	18	2232	$ 68.00	1.19	5.28	19	860	$ 34.00	0.60	2.64	2.5	593	22.60	0.40	1.75	1.	320	$ 17.18	0.30	1.33	$ 86.85	1.52	6.75	20.00	0.35	0.65	298.53	4.36	19.30	1288.	3706.
Aug "	188	23735	564.00	1.28	5.89	154	7058	282.00	0.64	2.87	20.	4760	186.60	0.43	1.88	8.23	4298	141.87	0.32	1.38	636.90	1.30	6.63	9785			1928.43	4.39	19.96	9905	43892
Sept "	536	67670	1224.11	0.91	4.21	396	18200	718.90	0.56	2.47	54.	12852	503.82	0.39	1.73	28.	14568	478.80	0.37	1.65	1856.95	1.44	6.37	1338.00			4980.61	5.82	16.93	29062	128745.
Oct "	512	64691	1439.63	1.19	5.28	378	17402	713.60	0.59	2.25	53.5	12733	499.14	0.41	1.83	23.73	11875	414.56	0.34	1.32	1630.95	1.35	5.99	22026			4918.34	4.06	16.05	27245	120696.
Nov "	351	44313	902.34	0.91	4.08	229	10281	421.52	0.43	1.91	43.	9675	441.18	0.45	1.99	18.5	9230	316.35	0.33	1.43	1320.98	1.35	6.00	13596			3367.65	3.44	16.15	22097	97890.
Dec "	311	39264	892.30	0.99	4.19	249	11434	468.79	0.49	2.10	40.	9480	432.28	0.45	2.10	16.	8336	281.34	0.30	1.30	1809.91	1.27	5.61	11728			3401.84	3.50	15.78	21564	95527.
Jany 86	311	39264	876.09	0.97	4.29	252	11630	476.83	0.53	2.34	24.5	5841	233.64	0.26	1.15	11.5	7697	259.71	0.29	1.27	1407.28	1.56	6.89	14258			3413.63	3.76	16.72	20423	90474.
Feby "	342	43177	966.10	1.12	4.95	251	11671	466.86	0.54	2.30	27.	6426	281.74	0.33	1.44	13.	6825	230.17	0.27	1.23	1268.87	1.47	6.50	11616			3382.90	3.85	17.00	19532	86525.
Mar "	416	52520	1187.46	1.02	4.50	316	14536	587.25	0.50	2.23	37.3	8925	367.00	0.30	1.35	23.	12144	409.74	0.33	1.35	1311.32	1.12	4.97	112.49			3965.48	3.39	15.02	26404	116972.
TOTALS	2903	376856	7521.98	0.96	4.24	2244	103004	4169.75	0.53	2.35	302.	71207	2958.00	0.37	1.67	143.	75533	2549.46	0.33	1.44	10755.84	1.37	6.00	114378.0	1.5	0.65	29696.64	3.78	16.40	172523	786427
Per Cent			25.85	%	%			14.38	%	%			10.16	%	%			8.76	%	%		36.97	%	%	5.93	%	%	102.04	%	%		
Actuals	A	B.	C.	D.	E.	F	G.	H.	I.	J	K	L	M.	N.	O	P	Q.	R	S	T.	U.	V.	W.	X.			Y.	Z	K.	AA.	BB.

58

ERRATA

Column BB Total cubic ft for Nov 1027900 instead of 97890. and total of Ties 2320 instead of 22097 AA

Also Totals of cubic ft for 9 mos = 791327 and total number of ties 178620.

Total of Col. B 350103 and Column C 101937.

Amount of pure Chloride absorbed (average of 9 mos.)

1st Calculated from Engineers reports = 9⁴/₁₀₀ of 1. per ct

2nd from chemical combination. that should result from total of Acid and Zinc = 8⁶/₁₀₀ of 1. per cent.

This is equal to about four times the minimum amount required i e. 2¹/₁₀₀ of 1 per cent

Per cent of Glue absorbed = about 3⁰/₁₀₀ per cent and of Tannin = 2²/₁₀₀₀ of 1 per cent.

"Deducting amount in solution not yet used.

Average cost per cubic ft for 9 months is 3.⁹/₁₀₀ cents and 16.⁴⁴/₁₀₀ cents per lie.

If no further breakage is encountered the average March to mil 3 ¹/₂ per cub ft and 15 cents per average lie can be maintained

To cover interest on investment maintenance insurance and supervision there should be added about ⁷/₁₀ cent per cub foot or three cents per lie making total per lie 18 cents

CALCULATION OF AMOUNT OF PURE CHLORIDE ABSORBED.

Let "a" = Wt of Chl. Sol 1½ ℔ strong = 63.37 lbs cub ft

"b" = average absorption of Chl. Sol = 27.5 per cent

"c" = Strength of Solution = 1½ ℔ = .015

"d" = Wt cub ft of wood = 31.2 lbs

"y" = per cent of pure Chloride absorbed.

Then abc. = lbs pure Chl per cubic foot = 0.2614 lbs.

and $\frac{abc}{d}$ = "y" = 84/100 of 1. per cent

Then by Chemical Formula

Total lbs Zinc used 101937.

Less 2 ℔ loss in impurities = 99897.26

Combines with (99897.26) 73/65 = 112192.24 lbs of Hcl gas

Lbs of comercial acid used 350193. Per cent by weight of Hcl gas = .32 per cent.

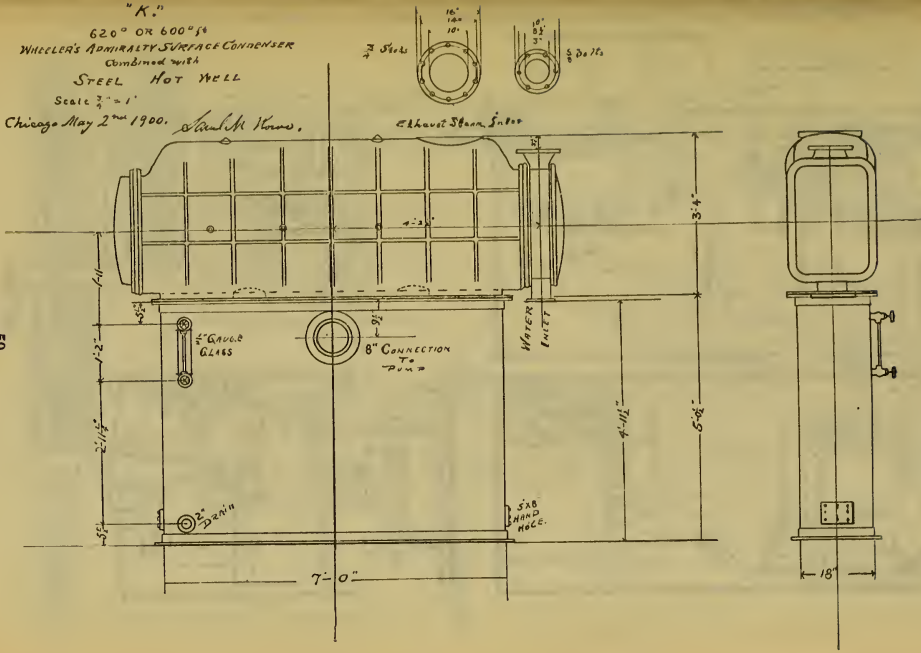
Resulting formula. $\frac{(73)}{2\,HCl} + \frac{(54.84)}{Na_2H_2O} + \frac{(62)}{2\,H} = \frac{(127)}{2NaCl} + \frac{(154.84)}{0.5\,M_2O} + H_2$ which makes 209015.68 lbs pure Zn Cl_2 and 4670 per cent Chloride.

Timber treated 791327 cubic feet at 31.2 lbs per cub ft = 24689402.4 lbs. then $\frac{209015}{24689402.4}$ = .008466 or about 8⁴/₁₀₀ of one per cent of wt of timber in pure Chloride

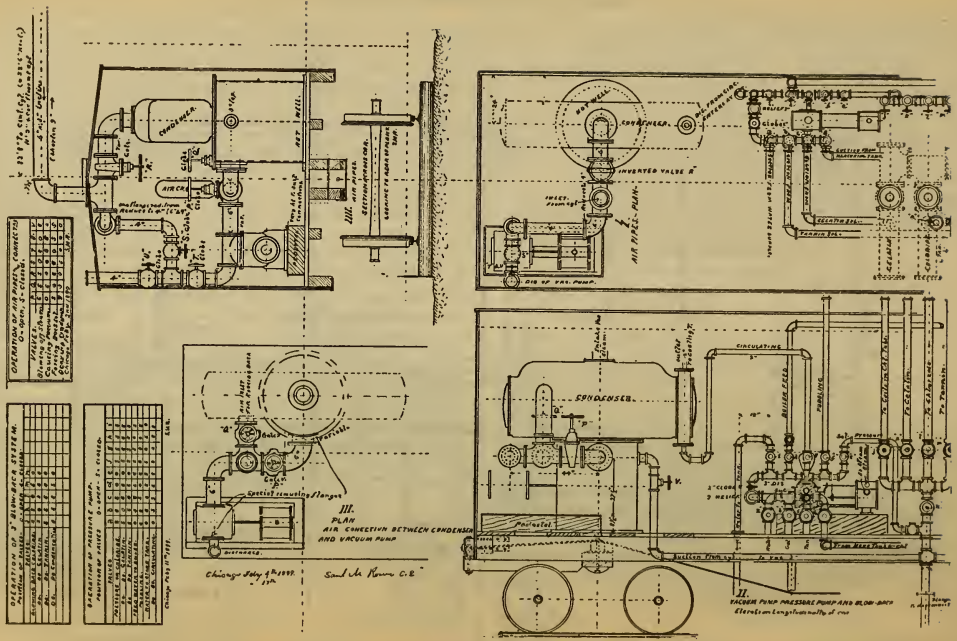
Las Vegas Apr 19th 1886

Daml. M Rowe

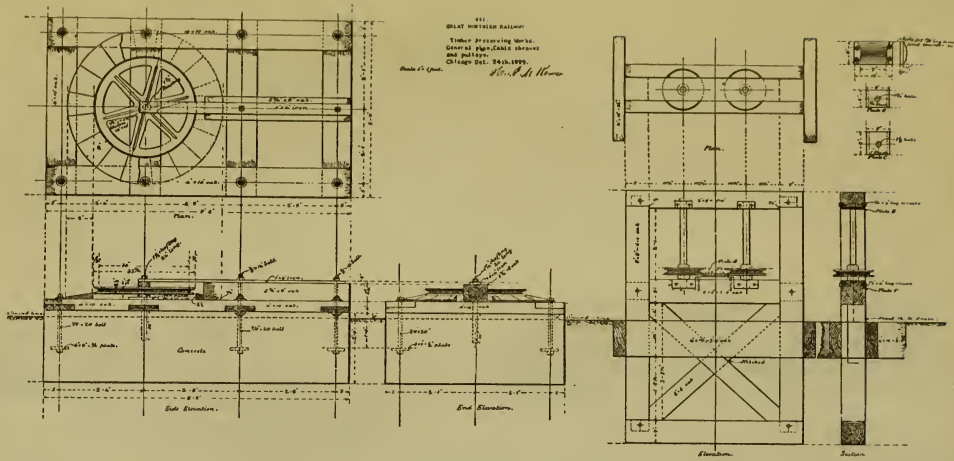
Resd Engr.



Surface Condenser and Hot-Well.

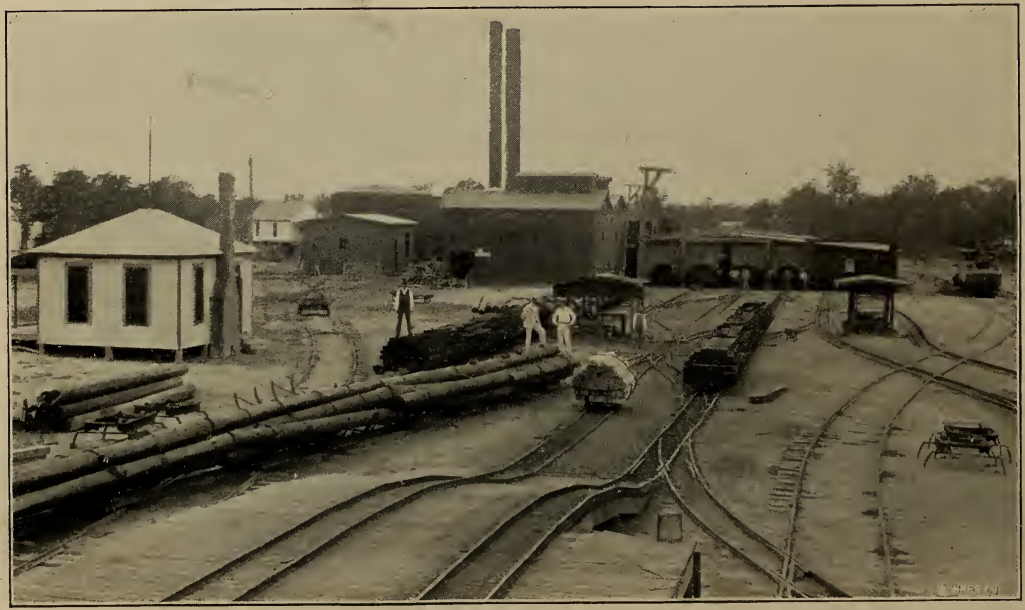


Portable Plant, Mt. Vernon, Ill. Showing condensation of machinery to go on half a flat car.

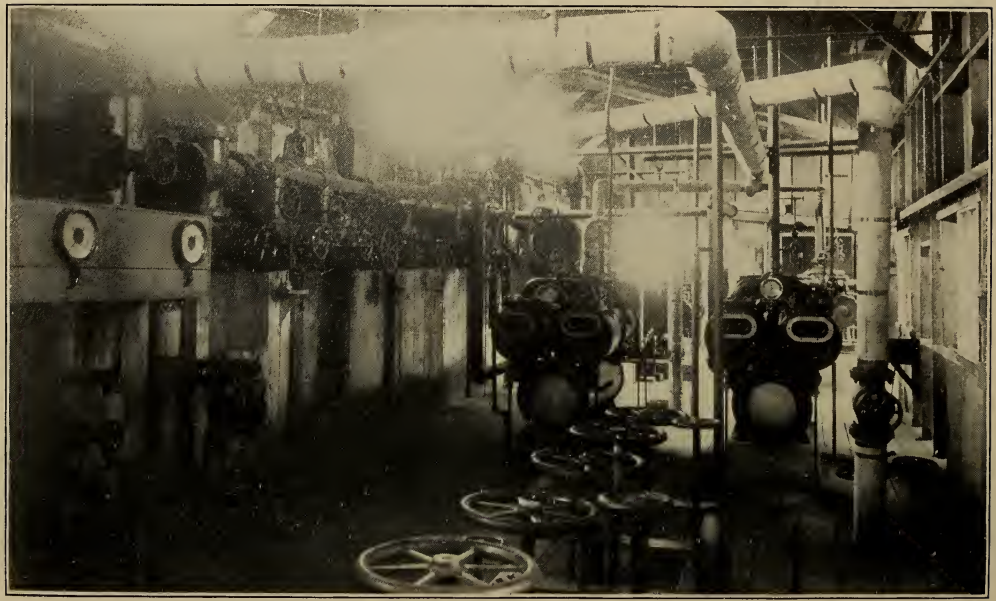


Snatch Pulleys and Guides.

ORIGINAL TWO-CYLINDER ZINC-TANNIN PLANT AT LAS VEGAS, N. M.

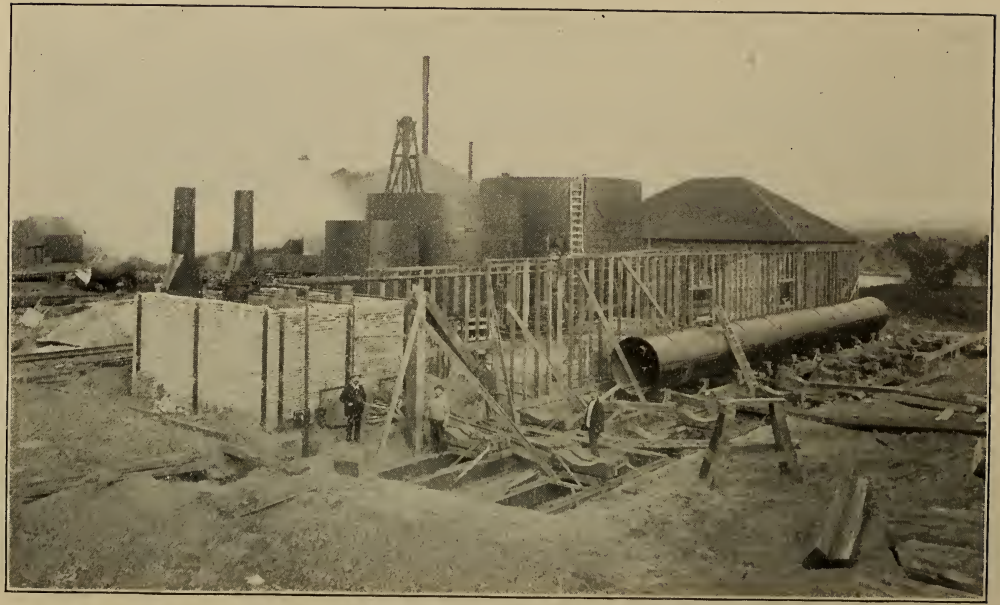


MACHINERY ROOM, SOMERVILLE, TEXAS.



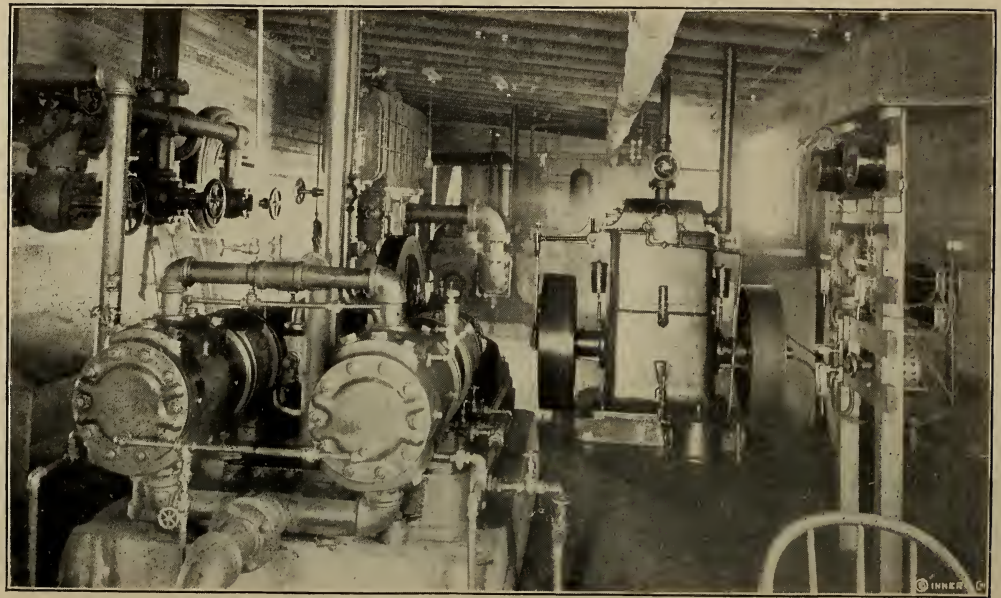
MACHINERY ROOM, SOMERVILLE, TEXAS.

BURNETTIZING PLANT OF THE C., B. & Q., AT EDGEMONT, S. D.



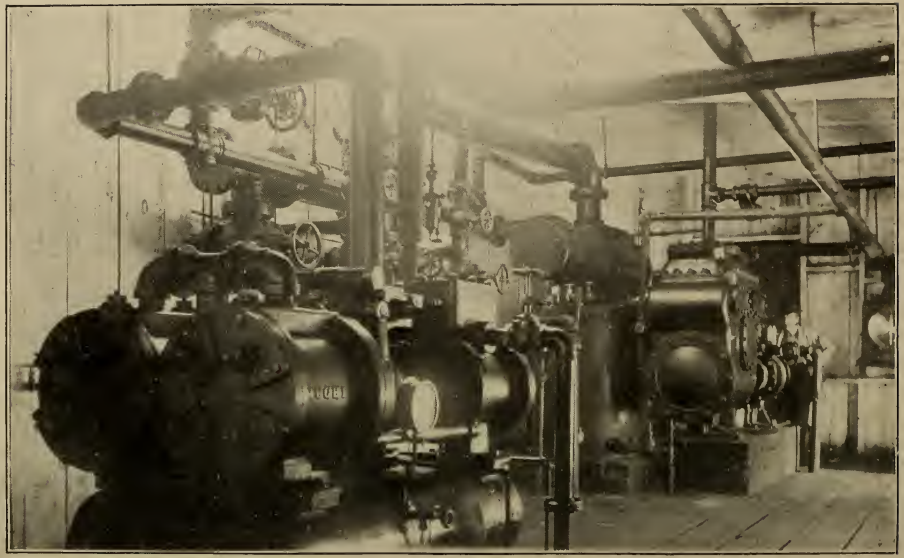
EDGEMONT BURNETTIZING PLANT DURING ERECTION.

EDGEMONT BURNETTIZING PLANT DURING ERECTION.



MACHINERY ROOM, EDGEMONT.

TWO RETORT WORKS, SANTA FÉ PACIFIC, BELLEMONT, ARIZ.



MACHINERY ROOM, BELLEMONT, ARIZ